PROJECT ABSTRACT

Ackermann Steering Geometry Demonstration Model

Project Abstract — projectech.in (Built to Order)

A hand-cranked bench model of Ackermann steering with protractor dials under each wheel, letting the student measure inner and outer steer angles and verify the Ackermann condition against theory.

01. Title

Ackermann Steering Geometry Demonstration Model

02. Introduction / Background

When a vehicle steers, the inner front wheel must turn through a larger angle than the outer wheel so that all wheels roll about a common centre without scrubbing. This Ackermann geometry is usually taught as a line diagram with an instant-centre construction; whether real hardware produces those angles, and how far a simple linkage deviates from the ideal, is never checked. This project builds a hand-cranked bench model: a steering wheel drives a rack-and-pinion block that steers two rubber-tyred wheels through a tie rod and kingpin mounts, with a printed protractor dial under each wheel. The student reads inner and outer angles directly and verifies the Ackermann condition by measurement, plotting measured versus theoretical angles across steering inputs.

03. Problem Statement

Ackermann steering is taught geometrically but never verified experimentally: students cannot say how closely a real linkage follows the ideal cotangent relationship or what adjusting the linkage changes. The Davis-versus-Ackermann discussion stays verbal. There is a need for a measurable, hand-operated model where both steer angles are readable at any input and comparable against theory the student computes from the model's own track and wheelbase.

04. Objectives

- Build a hand-cranked steering model (rack-and-pinion block, tie rod with turnbuckle adjustment, kingpin wheel mounts, two rubber-tyred wheels).
- Fit printed protractor dials (0–40° design range) under each wheel for direct angle reading.
- Enable measurement of inner and outer steer angles across steering inputs.
- Supply a worksheet guiding computation of theoretical Ackermann angles from measured track and wheelbase and tabulation of errors.
- Demonstrate linkage tuning via tie-rod adjustment.
- Document theory, build and procedure completely.

05. Proposed Methodology

The student turns the hand steering wheel, driving the pinion and sliding the rack; the tie rod rotates both wheel assemblies about their kingpins through angled steering arms. At each chosen steering input the inner angle is read from one dial and the outer from the other. Theoretical angles are computed from the model's measured track width and wheelbase using $\cot \delta_o - \cot \delta_i = \text{track/wheelbase}$. Measured and theoretical values are tabulated across inputs and the error plotted. The tie-rod turnbuckle is then adjusted and the series repeated to show how linkage tuning moves the measured curve toward or away from ideal. All angles are measured by the student on their own build; no values are claimed in advance.

06. System Architecture / Working

A hand wheel on a column drives a rack-and-pinion block; the sliding rack pushes and pulls a tie rod fitted with a turnbuckle, which rotates the two kingpin-mounted wheel assemblies through angled steering arms. The angled arms produce the Ackermann effect: the inner wheel rotates through a larger angle than the outer. Printed protractor dials fixed under each wheel give a direct angle readout at any steering input; the whole assembly sits on a plywood bench board with handwritten masking-tape labels on the tie rod, kingpins, rack and each wheel.

07. Hardware / Software Requirements

- Steel/wood bench frame with two wheel stations; rack-and-pinion steering block with hand wheel.
- Tie rod with turnbuckle adjustment, steering arms, kingpin wheel mounts with ball bearings.
- 2× rubber-tyred wheels; printed protractor dials (0–40° design range).
- Handwritten labels, assembly and adjustment documentation.
- No electronics or software are involved in this build.

08. Expected Outcomes

A working steering model that visibly steers the inner wheel sharper than the outer, a measured angle-versus-input table with computed theoretical values, an error curve showing the real linkage's deviation from ideal Ackermann geometry, and a documented tie-rod tuning study — all collected by the student during the build.

09. Applications

- Teaching aid for theory-of-machines and automotive chassis courses.
- Viva-ready demonstration of the Ackermann condition and the cotangent relationship.
- Linkage-tuning and kinematic-error study for machine-design reports.

10. Future Scope

A motorized steering input with logged angle data, an electronic angle-sensor variant replacing the protractor dials, and an extended comparison rig pairing the Ackermann layout with a Davis sliding-pair mechanism for a side-by-side study.